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Soviet Acquisition of Western Technology

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Soviet Acquisition of Western Technology

Introduction

The United States and its Allies traditionally have relied on the technological superiority of their weapons to preserve a credible counterforce to the quantitative superiority of the Warsaw Pact. But that technical superiority is eroding as the Soviet Union and its Allies introduce more and more sophisticated weaponry—weapons that all too often are manufactured with the direct help of Western technology.[1] Stopping the Soviets' extensive acquisition of military-related Western technology—in ways that are both effective and appropriate in our open society—is one of the most complex and urgent issues facing the Free World today.

This report describes the Soviet program to acquire US and Western technology, the acquisition mechanisms used, the spectrum of Western acquisitions that have contributed to Soviet military might, the projected Soviet priority needs for Western technology, and the problems of effectively stemming the transfer of Western technology that could someday find application in weapons used to threaten the West.

Soviet Acquisition of Western Technology: A National-Level Program

Since at least the 1930s, the Soviet Union has devoted vast amounts of its financial and manpower resources to the acquisition of Western technology that would enhance its military power and improve the efficiency of its military manufacturing technology. Today this Soviet effort is massive, well planned, and well managed—a national-level program approved at the highest party and governmental levels.

[1] While there are numerous interpretations of "technology" for weapons, it is defined in this report as the application of scientific knowledge, technical information, know-how, critical materials, keystone manufacturing and test equipment, and end products which are essential to the research and development as well as the series manufacture of modern high-quality weapons and military equipment. Western technology is defined as that technology developed by the Free World.

This program accords top priority to the military and military-related industry, and major attention is also given to the civilian sectors of Soviet industry that support military production.

The Soviets and their Warsaw Pact allies have obtained vast amounts of militarily significant Western technology and equipment through legal and illegal means. They have succeeded in acquiring the most advanced Western technology by using, in part, their scientific and technological agreements with the West to facilitate access to the new technologies that are emerging from the Free World's applied scientific research efforts; by spending their scarce hard currency to illegally purchase controlled equipment, as well as to legally purchase uncontrolled advanced Western technologies having military-industrial applications; and by tasking their intelligence services to acquire illegally those US and Western technologies that are classified and export controlled.

The Soviets have been very successful in acquiring Western technology by blending acquisitions legally and illegally acquired by different government organizations. The Soviet intelligence services—the Soviet Committee for State Security (KGB) and the Chief Intelligence Directorate of the Soviet General Staff (GRU)—have the primary responsibility for collecting Western classified, export-controlled, and proprietary technology, using both clandestine and overt collection methods. They in turn make extensive use of many of the East European Intelligence Services (see inset, p. 2); for their efforts in acquiring Western technology, these countries are paid in part with Soviet military equipment and weapons.

Clandestine acquisition of the West's most advanced military-related equipment and know-how by the KGB and GRU is a major and growing problem.

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East European Intelligence Services Acquire Technologies for the Soviet Union

In the late 1970s a former East European intelligence officer revealed organizational and targeting details related to Soviet-directed acquisitions of Western technology by East European intelligence services, particularly military-industrial manufacturing-related technologies that were given the highest priority for collection by at least one East European intelligence service. Many technologies were acquired through dummy firms established in Western Europe that were successful in securing some of the most advanced technologies in the West, including computer, microelectronic, nuclear, and chemical technologies.

In microelectronics, for example, many US firms were targeted through their affiliates in Western Europe; scientists, technicians, and commercial representatives also were successfully recruited to provide information during their trips to Europe. Although most of the military and defense-industrial information acquired by East European intelligence services went to the Soviets, much of it was used by the East Europeans themselves to benefit their military and civilian industries. The computer, microelectronic, and photographic areas were priority targets. The East European countries benefited considerably from microelectronic acquisitions, and could not have achieved the present level of development in their computer industry without illegal acquisitions of Western technology.

These intelligence organizations have been so successful at acquiring Western technology that the manpower levels they allocate to this effort have increased significantly since the 1970s to the point where there are now several thousand technology collection officers at work. These personnel, under various covers ranging from diplomats to journalists to trade officials, are assigned throughout the world.

Soviet foreign trade organizations, or enterprises, although quasi-independent entities, are partially subordinated to the Ministry of Foreign Trade, and their activities are closely coordinated by this Ministry. They have major responsibilities for both legal and illegal acquisitions and purchases; they work closely with the KGB and GRU in arranging trade diversions. East European trade companies assist them in clandestine and illegal acquisition operations.

Official Soviet and East European science and technology (S&T) organizations also play a major role in both open and clandestine acquisition of Western technology. The Soviet State Committee for Science and Technology (GKNT) is the key player in arranging government-to-government science and technology agreements to facilitate access to and the acquisition of established as well as new technologies, including those just emerging from Western universities, laboratories, and high-technology firms. It is the GKNT that oversees the allocation of scarce Soviet hard currency for the legal purchase by various Soviet organizations of selected Western technology for Soviet military purposes. If the GKNT is unable to acquire the necessary technology by open or legal means, it tasks Soviet intelligence to clandestinely acquire the technology.

It is the well-organized and well-coordinated use of all these organizations that has made the Soviet program to acquire Western technology so successful. As a result, the Soviets have acquired militarily significant technologies and critically important industrial Western technologies that have benefited every major Soviet industry engaged in the research, development, and production of weapon systems.

Soviet Mechanisms for Acquiring Western Technology

Soviet acquisition mechanisms include: *legal means* through open literature, through legal trade channels, and through student scientific and technological exchanges and conferences; *illegal means* through trade channels that evade US and Western (i.e. CoCom) [2] export controls, including acquisitions by their intelligence services through recruited agents and industrial

[2] The Coordinating Committee (CoCom) was established in 1949 to serve as the forum for Western efforts to develop a system of strategic export controls. It is composed of the United States, the United Kingdom, Turkey, Portugal, Norway, the Netherlands, Luxembourg, Japan, Italy, Greece, France, the Federal Republic of Germany, Denmark, Canada, and Belgium.

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espionage. While a large volume of technology is acquired by nonintelligence personnel, the overwhelming majority of what the United States considers to be militarily significant technology acquired by and for the Soviets was obtained by the Soviet intelligence services and their surrogates among the East European intelligence services. However, legal acquisitions by other Soviet organizations are important since it is often the combination of legally and illegally acquired technologies that gives the Soviets the complete military or industrial capability they need.

Because of the priority accorded to the military over the civilian sectors of the Soviet economy, Western dual-use technology—i.e., technology with both military and civilian applications—almost always finds its way first into military industries, and subsequently into the civilian sectors of industries that support military production. Thus, Soviet assurances that legally purchased dual-use technology will be used solely for civilian applications can seldom be accepted at face value.

Legal acquisitions generally have their greatest impact on the Soviets' broad industrial base, and thus affect military technology on a relatively long-term basis. The Soviet Kama Truck Plant, for example, was built over some seven years with massive imports of more than $1.5 billion worth of US and West European automotive production equipment and technology. Large numbers of military-specification trucks produced there in 1981 are now being used by Soviet forces in Afghanistan and by Soviet military units in Eastern Europe opposite NATO forces. Similarly, large Soviet purchases of printed circuit board technology and numerically controlled machine tools from the West already have benefited military manufacturing sectors.

The Soviets give priority to those purchases that meet the direct needs of the Soviet military-industrial complex by paying for them in hard currency. Over the past 10 years, the Soviets legally and illegally purchased large quantities of Western high-technology microelectronics equipment that has enabled them to build their own military microelectronics industry in a short time. This acquired capability in microelectronics is the critical basis for the present wide-ranging enhancements of Soviet military systems and for their continuing sophistication.

Acquisitions through illegal trade channels often have both industrial and military applications, and thus are important in the near term. Illegal acquisitions of technology fall into two general categories, both of which are extremely difficult to detect and monitor. One is the diversion of controlled technology from legitimate trade channels to proscribed destinations. This is done through US and foreign firms that are willing to engage in profitable impropriety; through agents-in-place in US or foreign firms or foreign subsidiaries of US firms; through Soviet- and East European—owned firms locally chartered in the West; and through foreign purchasing agents (including arms dealers). For instance, to evade the US embargo on microelectronic technology exports to the Soviet Union, the Soviets and their surrogates have set up dummy corporations in the West that purchase sophisticated microelectronics manufacturing equipment. This equipment is then shipped and reshipped, sometimes with the knowledge of individuals in the companies, to disguise its ultimate destination—the Soviet Union or Eastern Europe. Both the Soviet and Warsaw Pact intelligence services are in the mainstream of this illegal technology trade flow. The other type of diversion is an in-place diversion, in which legally acquired technology and equipment—in the computer area, for example—are put to military end uses not authorized in export license applications.

The acquisitions that most directly affect Soviet military development have come from intelligence collection and related illegal trade diversions. Soviet Bloc intelligence services have concentrated their effort in the United States, Western Europe, and Japan. These services target defense contractors and high-technology firms working on advanced technology (both classified and unclassified), foreign firms and subsidiaries of US firms abroad, and international organizations with access to advanced and/or proprietary technology, including access to computer data base networks throughout the world.

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Table 1

Major Fields of Technology of Interest to Soviet and East European Visitors to the United States

Computers	Architecture	Memories
	Automatic Control	N/C (Numerically Controlled) Units
	CAD (Computer-Aided Design)	Networks
	Cybernetics/Artificial Intelligence	Pattern Recognition
	Data Bases	Programming
	Image Processing Design	Robots
	Image Processing/Retrieval	Software
Materials	Amorphous	Metallurgy
	CAD	N/C Machine Tools
	Composites	Powder Metals
	Cryogenics	Superconductors
	Deformation	Testing/NDT (Non-Destructive)
Semiconductors	CAD	Design
	Circuits	Ion Implantation
	Defects	Production Technology
	Devices	SAW (Surface Acoustic Wave) Devices
Communications, Navigation, and Control	Antennas	Satellite Communications
	Microwave/Millimeter Waves	Signal Processing
	Radio Wave Propagation	Telecommunications
Vehicular/Transportation	Marine Systems	Shipbuilding
Laser and Optics	Fiber Optics	Optics
	Gas Lasers	Tunable Lasers
Nuclear Physics	Cryogenics	Reactors
	Fusion	Structural Designs
	Materials	Superconductors
	MHD (Magnetohydrodynamics)	
Microbiology	Genetic Engineering	

Both legal and illegal acquisitions of US and Western technology and equipment are coordinated with information obtained through the complex network of international governmental scientific and technical agreements and exchanges that the USSR maintains with the advanced industrial nations. These include know-how, equipment, and computer data base collection activities of Soviet scientists and engineers who participate in academic, commercial, and official S&T exchanges. Visiting Soviet and East European technical and student delegations to the United States generally consist of expert scientists, many of whom are connected with classified work in their home countries. Such was the case with the Soviet scientist who managed to get assigned to fuel-air explosives work. When he finished his US study programs, he almost certainly returned to the USSR to work on related weapons. Other Soviet and East European scientists have come to the United States to work in the aerohydrodynamic, cryogenic, optic, laser, computer, magnetic bubble computer memory, nuclear, microelectronic, and structural and electronic material areas. Given the military importance of these fields to the Soviet Union, it appears likely that a high percentage of these scientists will work on military-related programs in these areas after they return home.

From the beginning, Soviet candidates in various academic and scientific exchange programs have nearly always proposed research activities involving technologies in areas that have direct military applications and in which the Soviets are technologically deficient. Table 1 provides a list of the key high-technology fields that Soviet and East European

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visitors come to the United States to study, research, or discuss, many of which are on the US Militarily Critical Technology List today. In each of the past two years, more than a third of the 50 program proposals offered under the Graduate Student/Young Faculty Program of the International Research and Exchanges Board (IREX) has been completely unacceptable in terms of prospective technology loss, and many other programs needed to be modified or have access constrained before the exchanges could be allowed.

The Soviets correctly view the United States and several other Western countries as a continuing source of important and openly available scientific and technical information, which they take every opportunity to obtain access to. Some of the unclassified documents so acquired are previously classified materials which had been downgraded to unclassified through US procedures providing for automatic declassification after a stipulated period. When collected on a massive scale and centrally processed by the Soviets, this information becomes significant because it is collectively used by Soviet weapons designers and weapons countermeasure experts.

The Soviets also regularly attend high-technology trade shows, and attempt to visit commercial firms in the West, particularly small and medium-sized firms that are active in developing new technologies. These apparent trade promotion efforts often mask Soviet attempts to acquire emerging Western technological know-how before its military uses have been identified and government security controls have been applied. Emerging technologies are particularly vulnerable to foreign collection efforts of this type.

Soviet intelligence continues to place a high priority on the collection of S&T information on genetic engineering and futuristic weapons such as lasers and particle beam weapons. The Soviets have been stepping up their efforts to acquire new and emerging technologies such as very-high-speed integrated-circuit (VHSIC) and very-large-scale integration (VLSI) technology from Western universities and commercial laboratories for both military and commercial applications.

Over the past few years there has been an increased use of Soviet- and East European–owned firms locally chartered in the United States and abroad to exploit Western-controlled and military-related technology. There are more than twenty Soviet- and East European–owned firms in the United States, and near the end of the 1970s there were more than 300 similar firms in Western Europe. In addition to the United States, heavy concentrations are in the United Kingdom, Sweden, the Netherlands, Italy, the Federal Republic of Germany, France, Canada, Belgium, and Austria. These firms are avenues for Soviet acquisition of advanced Western technologies, as was shown when the US engineer arrested in late 1981 was charged with selling US secret documents to an East European intelligence officer employed by a Polish-owned firm chartered in Illinois (see inset, p. 6). Furthermore, firms chartered in the United States can legally purchase controlled US technology and study it without actually violating US export controls unless they attempt to export the equipment or related technical data from the United States without a license.

Soviet Acquisitions and Benefits

Today's recognition of the crucial role of Western technology in the development and production of Soviet weapon systems and related military equipment is not unique. Soviet dependence on Western technology was visible and clear-cut in the years immediately after World War II, when the Soviets stole Western nuclear secrets leading to their development of a nuclear weapon capability, and copied a US bomber in its entirety leading to production of their TU-4. To achieve major improvements in their military capability quickly, they exploited captured scientists and industrial plants and resorted to a combination of espionage, stealing, and copying Western systems.

Since that early period of near-complete reliance in the 1950s, the Soviets' dependence on Western technology to develop their weapons has decreased. Nevertheless, despite several decades of Soviet priorities focused on science, technology, and weapon systems, the Soviets, because of their inability to be innovative

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US Radar Expert Passes Over 20 Significant Classified Reports on Future US Weapon Systems to Intelligence Agent

William H. Bell, a radar project engineer for a high-technology US defense firm was recruited by an intelligence officer who operated under cover as a vice president of the Polish firm called Polamco. This firm is a subsidiary of the Polish Government Corporation and is incorporated in Illinois and Delaware. It began as an importer/exporter of machinery, parts and tools and as a consultant to firms exporting these products to Poland. The recruitment began as a simple friendship between neighbors with mutual sporting interests, grew quickly to include their families, then to proving Bell's credentials by showing a classified document to the agent, and then to passing microfilm copies of classified reports at meeting places in the US, Switzerland, and Austria. Mr. Bell was in financial straits and was easily influenced by the cash proffered—a total of $110,000 over a three-year period. In all, over 20 highly classified reports on advanced future US weapon systems or their components were passed to the Polish Intelligence Service and probably eventually to the Soviet Intelligence Service.

Among the classified reports, those of prime importance to the West included: the F-15 look-down-shoot-down radar system, the quiet radar system for the B1 and Stealth bombers, an all-weather radar system for tanks, an experimental radar system for the US Navy, the Phoenix air-to-air missile, a ship-borne surveillance radar, the Patriot surface-to-air missile, a towed-array submarine sonar system, a new air-to-air missile, the improved HAWK surface-to-air missile, and a NATO air-defense system. The information in these documents put in jeopardy existing weapons and advanced future weapon systems of the United States and its Allies. The acquisition of this information will save the Polish and Soviet Governments hundreds of millions of dollars in R&D efforts by permitting them to implement proven designs developed by the United States and by fielding operational counterpart systems in a much shorter time period. Specifications on current and future US weapon systems will enable them to develop defensive countermeasure systems.

and effectively apply new technology to weapons developments, still depend on Western technology and equipment to develop and manufacture some of their advanced weapon systems more quickly.

Today, Soviet military designers carefully choose the Western designs, engineering approaches, and equipment most appropriate to their deficiencies and needs. These needs are still substantial and pervade almost every area of weapons technology and related manufacturing equipment. Table 2 lists classes of Western technology acquired by the Soviets and East Europeans and illustrates the wide range of Soviet military technology needs. In the following paragraphs of this section, Soviet Bloc acquisitions have been grouped according to their likely applications: strategic systems, aircraft systems, naval systems, and tactical systems. Also cited are acquisitions in the microelectronic and computer areas that have broad application to military and industrial programs. In certain of these areas, notably the development of microelectronics, the Soviets would have been incapable of achieving their present technical level without the acquisition of Western technology. In other areas, acquisitions have allowed the Soviets to reduce the indigenous effort they would otherwise have had to expend.

The Soviets' strategic weapons program has benefited substantially from the acquisition of Western technology. The striking similarities between the US Minuteman silo and the Soviet SS-13 silo very likely resulted from acquisition of US documents and expedited deployment of this, the first Soviet solid-propellant ICBM. The Soviets' ballistic missile systems in particular have, over the past decade, demonstrated qualitative improvements that probably would not have been achieved without Western acquisitions of ballistic missile guidance and control technology. The most striking example of this is the marked improvement in accuracy of the latest generation of Soviet ICBMs—an improvement which, given the level of relevant Soviet technologies a decade ago, appears almost certainly to have been speeded by the acquisition of Western technology. Their improved accuracy has been achieved through the exploitation and development of good-quality guidance components—such

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Table 2

Selected Soviet and East European Legal and Illegal Acquisitions From the West Affecting Key Areas of Soviet Military Technology

Key Technology Area	Notable Success
Computers	Purchases and acquisitions of complete systems designs, concepts, hardware and software, including a wide variety of Western general purpose computers and minicomputers, for military applications.
Microelectronics	Complete industrial processes and semiconductor manufacturing equipment capable of meeting all Soviet military requirements, if acquisitions were combined.
Signal Processing	Acquisitions of processing equipment and know-how.
Manufacturing	Acquisitions of automated and precision manufacturing equipment for electronics, materials, and optical and future laser weapons technology; acquisition of information on manufacturing technology related to weapons, ammunition, and aircraft parts including turbine blades, computers, and electronic components; acquisition of machine tools for cutting large gears for ship propulsion systems.
Communications	Acquisitions of low-power, low-noise, high-sensitivity receivers.
Lasers	Acquisitions of optical, pulsed power source, and other laser-related components, including special optical mirrors and mirror technology suitable for future laser weapons.
Guidance and Navigation	Acquisitions of marine and other navigation receivers, advanced inertial-guidance components, including miniature and laser gyros; acquisitions of missile guidance subsystems; acquisitions of precision machinery for ball bearing production for missile and other applications; acquisition of missile test range instrumentation systems and documentation and precision cinetheodolites for collecting data critical to postflight ballistic missile analysis.
Structural Materials	Purchases and acquisitions of Western titanium alloys, welding equipment, and furnaces for producing titanium plate of large size applicable to submarine construction.
Propulsion	Missile technology; some ground propulsion technology (diesels, turbines, and rotaries); purchases and acquisitions of advanced jet engine fabrication technology and jet engine design information.
Acoustical Sensors	Acquisitions of underwater navigation and direction-finding equipment.
Electro-optical Sensors	Acquisition of information on satellite technology, laser rangefinders, and underwater low-light-level television cameras and systems for remote operation.
Radars	Acquisitions and exploitations of air defense radars and antenna designs for missile systems.

as gyroscopes and accelerometers. The quality of these instruments, in turn, depends to a considerable degree on the quality of the small, precision, high-speed bearings used.

Through the 1950s and into the 1960s, the Soviet precision bearing industry lagged significantly behind that of the West. However, through legal trade purchases in the 1970s, the Soviet Union acquired US precision grinding machines for the production of small, high-precision bearings. Similar grinding machines, having lower production-rate capabilities, were available from several foreign countries. Only a few of these machines, either US or foreign, would have been sufficient to supply Soviet missile designers with all the quality bearings they needed. These purchases provided the Soviets with the capability to manufacture precision bearings in large volume sooner than would have been likely through indigenous development. The Soviets probably could have used indigenous grinding machines and produced the required quality of bearings over a long period by having an abnormally high rejection rate.

While some of the Soviet acquisition in the aircraft area appears directed toward the development of countermeasures against Western systems, the Soviets appear to target data on Western aircraft primarily to acquire the technology. Furthermore, while the Soviets have acquired a large amount of hardware and data from planes downed or captured in Vietnam and elsewhere, they continue to attempt to acquire the most advanced technologies through both legal and illegal transactions with the West. Assimilation of

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Western technology has been of great benefit to both their military and commercial aircraft development programs—to the extent that aircraft from certain Soviet military design bureaus are to a significant degree copies of aircraft of Western design. Soviet military aircraft designers have "ordered" documents on Western aircraft and gotten them within a few months, including plans and drawings for the US C-5A giant transport aircraft early in its development cycle; these plans, although dated now, have contributed to current Soviet development of a new strategic military cargo plane. Designers were in particular need of data on US technological advances, but more importantly, they needed information on aerospace manufacturing techniques.

Soviet aircraft designers have been interested in US military transports and wide-body jets and probably have managed to accelerate the development programs for their IL-76 Candid and IL-86 transports. The IL-86 looks much like the Boeing 747 and the IL-76 resembles the C-141. Neither system is an identical copy.

The IL-76 also is used by the Soviets as the platform for their new AWACS (Airborne Warning And Control System), which is expected to be operational in the mid-1980s. This system will provide the Soviets with a major improvement in attacking low-flying missiles and bombers. The Soviet AWACS is strikingly similar in many ways to the US AWACS, and is a major improvement over their old AWACS.

The Soviets' acquisition effort in the naval systems area reflects well the two major factors that motivate their requirements: the acquisition of technology not readily available to them—yet critical to their programs—and the acquisition of equipment which, while producible in the Soviet Union, allows them to divert resources to more pressing naval programs. The Soviets appear to have concentrated their acquisitions in areas related to aircraft carriers, deep sea diving capabilities, sensor systems for antisubmarine warfare and navigation, and ship maintenance facilities. In the maintenance area, two huge floating drydocks purchased from the West for civilian use by the Soviets have been diverted to military use. Drydocks are critical for both routine and fast repair of ships damaged in warfare. In 1978, when the Soviets took possession of one of the drydocks, they diverted it to the Pacific Naval Fleet. The other was sent to the Northern Fleet in 1981.

These drydocks are so large that they can carry several naval ships. More importantly, they are the only drydock facilities in either of the two major Soviet fleet areas—Northern or Pacific—capable of servicing the new Kiev-class V/STOL aircraft carriers. Soviet advanced submarines carrying ballistic missiles, Soviet Kiev aircraft carriers, and Soviet destroyers were among the first ships repaired in these drydocks. It is important to note that the drydocks themselves are so large that no Soviet shipyard would have been capable of accommodating their construction without major facility modifications, associated capital expenditures, and interruptions in present weapons programs. Their importance will be even more pronounced when the Soviets construct the still-larger carriers (for high-performance aircraft) projected for the 1990s. The Soviets even have acquired Western aircraft carrier catapult equipment and documentation for this larger carrier; catapult technology, though relatively common in the West, is outside the Soviet experience.

Within the past few years, the USSR also has contracted for or purchased foreign-built oceanographic survey ships equipped with some of the most modern Western-manufactured equipment. In place of US equipment that was embargoed, other Western equipment has been installed on the ships. This modernization of what is the world's largest oceanographic fleet with Western technology will help support the development of Soviet weapon system programs and antisubmarine systems against the West.

Although the Soviets have a strong indigenous technology base that could support the development of much of their tactical weapons systems, this does not prevent them from maintaining an ambitious program for acquiring and benefiting from Western technology in this area. In some cases, their acquisitions satisfy deficiencies in Soviet technology; smart weapons technology and electro-optical technology are examples of

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Table 3

Microelectronic Equipment and Technology Legally and Illegally Acquired by the Soviet Bloc

Equipment or Technology	Comments
Process Technology for Microelectronic Wafer Preparation	The Soviets have acquired hundreds of specific pieces of equipment related to wafer preparation, including expitaxial growth furnaces, crystal pullers, rinsers/dryers, slicers, and lapping and polishing units.
Process Technology for Producing Circuit Masks	Many acquisitions in this area include computer-aided design software, pattern generators and compilers, digital plotters, photorepeaters, contact printers, mask comparators, electron-beam generators, and ion milling equipment.
Equipment for Device Fabrication	Many hundreds of acquisitions in this area have provided the Soviets with mask aligners, diffusion furnaces, ion implanters, coaters, etchers, and photochemical process lines.
Assembly and Test Equipment	Hundreds of items of Western equipment, including scribers, bonders, probe testers, and final test equipment have been acquired by the Soviets.

this. Signal and information-processing technology, particularly for Soviet air defense systems, is another. More often, however, technology is exploited to speed up a developmental program or to improve upon original Western designs in an expeditious manner. The Soviets appear to have concentrated their tactical systems acquisitions on Western tank, antitank, and air defense–related technology and equipment in order to derive concepts and know-how to benefit their weapons programs and to design countermeasures to the Western systems. The Soviet SA-7 heat-seeking, shoulder-fired antiaircraft missile contains many features of the US Redeye missile. Such acquisitions have enabled the Soviets to obtain advanced tactical weapon capabilities sooner than otherwise would have been possible.

Western equipment and technology have played a very important, if not crucial, role in the advancement of Soviet microelectronic production capabilities. This advancement comes as a result of over 10 years of successful acquisitions—through illegal, including clandestine, means—of hundreds of pieces of Western microelectronic equipment worth hundreds of millions of dollars to equip their military-related manufacturing facilities. These acquisitions have permitted the Soviets to systematically build a modern microelectronics industry which will be the critical basis for enhancing the sophistication of future Soviet military systems for decades. The acquired equipment and know-how, if combined, could meet 100 percent of the Soviets' high-quality microelectronic needs for military purposes, or 50 percent of all their microelectronic needs.

Table 3 identifies the microelectronic production-related equipment that has been acquired by the Soviet Bloc. These acquisitions have been grouped into areas related to the four steps required to produce a microchip: wafer preparation, circuit-mask making, device fabrication, and assembly and testing.

Soviet computer technology has long been limited by fabrication and production technology problems and by difficulties in software development. Since 1969 the USSR and East European countries have been developing a family of general purpose computers known as the Ryad series. These computers, which make up virtually the total Soviet and East European effort in large general purpose computers, have been and will continue to be used in a wide variety of civil and military applications. Western technology has been important to development of the Ryad series by providing proven design directions both at the system and component levels. The architectural designs of the

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Ryad computers, for example, are patterned after those of the highly successful mass produced IBM 360 and 370 series, computers that are used in a wide range of applications and are highly serviceable in the field.

With this approach, the Soviets and East Europeans eliminated many of the risks involved in undertaking the development and production of a new series of general purpose computers, and saved considerable amounts of manpower and time. Since the early 1970s the Soviets and East Europeans have legally purchased more than 3,000 minicomputers, some of which are now being used in military-related organizations. Furthermore, they are also developing minicomputers that are direct copies of Western models. Soviet and East European development of computer systems has been aided by all available means—legal and illegal, including clandestine—for acquiring the needed technical know-how.

Thus, the Soviets and their Warsaw Pact allies have derived significant military gains from their acquisitions of Western technology, particularly in the strategic, aircraft, naval, tactical, microelectronics, and computer areas. This multifaceted Soviet acquisitions program has allowed the Soviets to:

- Save hundreds of millions of dollars in R&D costs, and years in R&D development lead time (see inset).
- Modernize critical sectors of their military industry and reduce engineering risks by following or copying proven Western designs, thereby limiting the rise in their military production costs.
- Achieve greater weapons performance than if they had to rely solely on their own technology.
- Incorporate countermeasures to Western weapons early in the development of their own weapon programs.

These gains are evident in all areas of military weapons systems. While difficult to quantify, it is clear that the Western military expenditures needed to overcome or defend against the military capabilities derived by the acquisition of Western technology far outweigh the West's earnings from the legal sales to the Soviets of its equipment and technology.

Soviet Intelligence Officer Reveals Technology Acquisition Saved Soviet Military Hundreds of Millions of Rubles

A former Soviet intelligence officer revealed that information on Western military-related technology acquired by the Soviet intelligence services saved the Soviet military industry hundreds of millions of rubles. The acquisition of Western technology operationally was assigned the highest priority for collection by local residencies in key West European countries because of the relatively easy access to much US and Western technology in Europe and the praise being received by the services for their acquisition efforts.

These acquisitions were directed by the military manufacturing industries under the Council of Ministers, and there was intense competition between the intelligence services to acquire Western technology needed for weapons development programs. Of particular need by Soviet weapons designers has been the acquisition of knowledge on special materials, notably the weaving of carbon filaments in a three dimensional configuration which the services were tasked to acquire. The end products from this 3-D carbon-carbon weaving technology are useful for ablative heat shields for high velocity reentry vehicles (the warhead part of ICBMs and SLBMs) and for other portions of rocket motors for large missiles. The Soviet acquisition of some of this technology is likely to enable them to eventually gain a capability for increased military options against the West—a capability that otherwise would have taken them several additional years to develop themselves. The intelligence services also worked closely with scientists from the Soviet military manufacturing industries and even planned joint operations against Western Trade and Equipment Fairs in order to acquire needed Western technology.

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Outlook for the 1980s

The Soviets' military R&D and weapon test-and-evaluation efforts are continuing at a rapid pace. Several hundred development projects for weapons systems and major system elements are now under way, and it is expected that through the 1980s the number of new or modified advanced Soviet weapon systems emerging from these projects into production and deployment will remain at the high levels of the last two decades—some 200 weapon systems per decade.

Soviet military manufacturing capacity increased by a significant 80 percent during the 1960s and 1970s, and new plant expansion now under way at one-fourth of their key weapons manufacturing facilities will add considerably to their capabilities. These new facilities will be ready to produce weapons in the next four to 10 years. Plant expansion is in the following areas: ground warfare vehicles, including new tanks; aviation, including facilities for a new B-1-type bomber and a new long-range military transport aircraft having strategic airlift capabilities; naval shipbuilding, including submarines for ballistic missiles and cruise missiles, as well as full-size aircraft carriers for high-performance aircraft capable of competing with the United States in global operations; and electronic and microelectronic manufacturing facilities throughout the USSR. The development and production of new Soviet weapons at these facilities is sure to be more complex and costly than during the 1970s.

All of this military development and plant expansion activity, however, is taking place at a time when the Soviet economy has reached its lowest level of growth since World War II. Soviet annual GNP growth may well be limited to an average of 1 to 2 percent by the mid-1980s. Stagnation in industrial sectors that are key to both the civilian and the military sectors will make it increasingly difficult for the Soviets to satisfy the needs of both. Thus, Soviet leaders will have to make tough choices among defense, investment, and consumption; the competition among rival claimants for resources will become intense. Under these conditions, it may be impossible for the Soviets to maintain current growth in military production without hurting the civilian economy.

Despite these economic difficulties, there are no signs that the Soviets are shifting resources away from the military sector or slowing down development of weapon systems that will be entering the production stage by mid-decade. New generations of Warsaw Pact weapons will require selected critical component and modern manufacturing technologies. It is in these areas that Soviet illegal acquisitions of Western technology, complemented by legal acquisitions, are most likely to be concentrated over the next five to 10 years.

Among the more important technologies are microelectronics, computers, and signal processing. Microelectronics will play a very significant role in advances in computers and signal processing, and all of these technologies will be important in developing advanced Soviet missile, aircraft, naval, and tactical weapon systems, and associated detection systems. Additional projected Soviet technological needs related to such systems are presented in the appendix.

As the result of both tactical and strategic force modernizations, Soviet and Warsaw Pact military manufacturers are increasingly pressed by large-scale production requirements and the related need to control manufacturing and materials costs. Thus, particularly critical for the 1980s are Soviet needs to improve their manufacturing capability. To a large extent, the level of manufacturing technology in Soviet plants determines the Soviets' capability to move new technology from R&D into military applications. Manufacturing technologies play a significant role not only in the development of advanced component technologies, such as microelectronics and computers, but also in the actual production of modern military systems.

Future Soviet and Warsaw Pact acquisition efforts—including acquisitions by their intelligence services—are likely to concentrate on the sources of such component and manufacturing technologies, including:

- Defense contractors in the United States, Western Europe, and Japan who are the repositories of military development and manufacturing technologies.

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- General producers of military-related auxiliary manufacturing equipment in the United States, Western Europe, and Japan.

- Small and medium-size firms and research centers that develop advanced component technology and designs, including advanced civil technologies with future military applications.

The combination of past Soviet acquisition practices and projected Soviet military needs indicates that the United States and its Allies are likely to experience serious counterintelligence and related industrial security and export control problems over the next five to 10 years.

The task of stopping Soviet Bloc intelligence operations aimed at Western military and industrial technologies already poses a formidable counterintelligence problem, both in the United States and abroad. But that task is likely to become even more difficult in the future as several trends identified in the 1970s continue into the 1980s:

- First, since the early 1970s, the Soviets and their surrogates among the East Europeans have been increasingly using their national intelligence services to acquire Western civilian technologies—for example, automobile, energy, chemicals, and even consumer electronics.

- Second, since the mid-1970s, Soviet and East European intelligence services have been emphasizing the collection of manufacturing-related technology, in addition to weapons technology.

- Third, since the late 1970s, there has been increased emphasis by these intelligence services on the acquisition of new Western technologies emerging from universities and research centers.

The combined effect of these trends is a heavy focus by Soviet Bloc intelligence on the commercial sectors in the West—sectors that are not normally protected from hostile intelligence services. In addition, the security provided by commercial firms is no match for the human penetration operations of such foreign intelligence services. But the most alarming aspect of this commercial focus by Soviet Bloc intelligence services is that as a result of these operations the Soviets have gained, and continue to gain, access to those advanced technologies that are likely to be used by the West in its own future weapons systems.

The Soviet intelligence effort against Western defense contractor firms poses a serious problem in itself. With more than 11,000 such firms in the United States and hundreds of subsidiaries abroad, US counterintelligence efforts are stretched thin. Protection of US firms abroad from hostile intelligence threats is the responsibility of host governments, but they too are feeling the burden of well-orchestrated Soviet Bloc efforts. The Soviet intelligence threat and the illegal trade problem appear to be severe in Japan. It appears that Western industrial security—both defense and commercial—will be severely tested by the Soviet intelligence services and their surrogates among the East European intelligence services during the 1980s.

Western industrial nations also can expect increased Soviet Bloc intelligence activities directed at the acquisition of their key industrial technologies. Western export controls are presently being updated and broadened; the CoCom allies have recently agreed to strengthen controls and to enhance their enforcement. Moreover, serious hard currency shortages, along with generally increased restrictions on Soviet S&T visitors to the United States, will make the Soviets even more dependent on intelligence and other illegal efforts to acquire the goods and equipment they will need.

The massive, well-planned, and well-coordinated Soviet program to acquire Western technology through combined legal and illegal means poses a serious and growing threat to the mutual security interests of the United States and its Allies. In response, the West will need to organize more effectively than it has in the past to protect its military, industrial, commercial, and scientific communities.

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Appendix

Projected Soviet Technological Needs and Acquisition Targets Through the 1980s

Given the dynamic nature of their collection program, it is expected that the Soviets will continue their attempts to acquire a broad range of Western technologies. Certain areas, however, represent priority collection targets for them; these areas are critical to the Soviets' enhancement of their weapons capability.

Over the past decade, the Soviets' most pronounced improvements in strategic weaponry have been in the development of a MIRV ballistic missile capability and a significant improvement in the accuracy of their ICBMs. The former capability was made possible largely through the introduction of onboard digital computers and the latter through the improvement in the quality of the missile guidance systems and the procedures used to calibrate them. Technology acquisitions from the West contributed significantly to these improved capabilities.

The Soviets probably will continue to make their highest priority the acquisition of Western microelectronics and computer technology for in-flight guidance computers. This acquisition effort will be motivated by a desire to overcome reliability problems and also to provide the on-board processing capability required for the development of new guidance options with the potential for extremely high accuracies.

The Soviets will also give top priority to acquiring information on the latest generation of US-inertial components upon which the MX ICBM and the Trident SLBM guidance systems are based. Despite the past accuracy improvements of Soviet ICBMs, these two US systems incorporate technologies beyond present Soviet technological capabilities. Moreover, their SLBM accuracies are significantly behind those of US systems. In addition to information on hardware, the Soviets are expected to seek calibration software algorithms which, as the guidance instruments themselves reach their practical performance limit, would allow for continued improvement in weapon system accuracy.

Western solid rocket propulsion technology also will be a high-priority Soviet acquisition target in the 1980s. While the Soviets have vast experience with the liquid-propellant systems which represent the bulk of their ballistic missile force, they are shifting their emphasis to solid propulsion systems, which have practical advantages over liquid systems in a variety of applications. At the same time, the Soviets have had only limited success with the progress of their solid-propulsion program. They probably will pursue the acquisition of information on solid-propellant production procedures, and propellant grain design, motor case, and rocket nozzle technologies.

The Soviets' ABM R&D effort has continued apace since the 1960s. As a result, they have gained considerable expertise in the development of large fixed-site radars for early warning, tracking, and engagement, and their interceptor technology has also improved substantially over the years. Areas remain, however, in which the Soviets will still seek and would benefit from sophisticated Western ABM technology. These include signal processing for detection, discrimination, target assignment, and sensor technology, particularly in the long-wave infrared portion of the electromagnetic spectrum applicable toward improving their launch detection capability.

Priority Soviet targets in the aircraft area will include Western materials technology, particularly composite materials to allow weight-efficient designs. The Soviets would also benefit from the acquisition of certain engine technologies, in particular those critical to the development of high-bypass turbofans for large strategic airlift type of aircraft. While, in general, Soviet avionics technology appear adequate, the Soviets have yet to demonstrate a capability to deploy reliable, accurate airborne inertial navigation systems for long-range navigation and weapons delivery. Thus, while long used in the West, these systems are still prime candidates for acquisition.

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Very high priority probably will be given to the acquisition of computer-aided aircraft design technology, an area in which the Soviets are clearly impressed by US progress. In general, they also will continue to benefit from the acquisition of efficient aircraft production technology from the West to reduce costs.

While the Soviets have a strong indigenous air defense radar and missile technology, their general lag in microelectronics and microprocessing will direct them to attempt wherever possible in the West the acquisition of advanced signal-processing hardware and software.

The Soviets will continue to emphasize the acquisition of naval-related technologies applicable to improving their antisubmarine warfare capabilities, an area in which much Western technology is superior to theirs. Thus, a significant effort to acquire acoustic sensor technology can be expected, in particular that technology applicable to the development of large towed acoustic arrays that would assist the localization of Western submarines in open waters. They probably will also target the acquisition of Western signal-processing hardware and software required to fully exploit the detection capabilities of these sensors.

Another critical problem area to which the Soviets will direct acquisition is that of submarine quieting. Here also the Soviets lag the West significantly. As a result, not only are their submarines more vulnerable to detection, but the self-generated noise reduces the effectiveness of their own acoustic sensors.

An area in which the Soviets have historically lagged behind the West is precision submarine navigation—in particular, in the development of submarine inertial navigation systems. The need for improvements here will become more pressing as the Soviets develop long-range cruise missiles for land attack which require precise knowledge of launch location.

The Soviets also will continue to target technologies related to the design and construction of large aircraft carriers (for high-performance aircraft) to reduce the likelihood of poor design choices that would arise in what is for them an entirely new type of construction program.

Much of the Soviet acquisition effort in the area of tactical weapons is likely to be targeted against seeker and sensor technology for tactical missiles and precision-guided munitions. The Soviets will apply considerable effort in particular to acquiring advanced Western electro-optical technology including that related to antitank weapons. As in other weapons areas, the signal processing and microelectronics technologies supporting tactical weapon systems will also be priority acquisition targets. Technical documentation on entire weapon systems, if obtained, will be used to develop countermeasures.

In the microelectronics area the USSR is now at the stage of implementing its LSI (large-scale integration) technology to high-volume production. Despite the large acquisitions of Western technology and production equipment over the past 10 years which have brought them to the LSI level, additional acquisitions from the West are needed for the more sophisticated weapons projects of the future. Ever-increasing needs for higher precision Western equipment will extend at least through the 1980s.

In addition, the Soviets will require considerable expansion of their microelectronic material base to support continued expansion of integrated-circuit production. In this regard, the USSR is seeking Western help to build two or three poly-silicon plants that will more than double current Soviet capacity for military applications. Also, with increasing advances in the technology, the USSR already will be seeking additional Western assistance in key complementary technologies such as packaging and printed circuit board production.

The USSR is expected to focus its future acquisitions efforts on the emerging technologies related to very-high-speed integrated circuits (VHSIC) and very-large-scale integration (VLSI). It is important to note that, while VHSIC is thought of as a military development program, and VLSI as a civilian technology, there is little difference between the two as far as Soviet production needs are concerned. The same materials, production, and test equipment will be used to produce both. In both of these technological areas, the USSR has developed effective means for illegally acquiring Western advanced products.

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Prime Soviet collection efforts in computer technology through the 1980s are likely to include large-scale scientific computers such as the US-built CRAY-1 Computer. Computers of this class offer significant improvements over Soviet models in weapons-systems design and simulation and in the processing of numerical data for many military applications. Other hardware targets will include: very dense random-access memory chips; high-capacity disk drives and packs; the so-called "superminicomputer" class of machines; and the latest in general purpose computer technology. All of the above targets offer opportunities for significant performance improvements and represent technologies of substantial Soviet lag.

In computer software, the Soviets will continue to attempt to collect IBM programs and programs of other vendors written for these machines because of past Soviet decisions related to copying IBM computers. The large and growing number of IBM-compatible computers in the USSR means that collection activity in this area can be expected to increase. The compelling attraction of computer networks also should spur great Soviet interest in acquiring network-control software and other programs related to networking.

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